STANFORD RESEARCH INSTITUTE

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MECHANICAL PROPERTIES OF CROSSLINKED POLY(METHYL METHACRYLATE) POLYMERS UNDER SPACE ENVIRONMENTAL CONDITIONS

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I INTRODUCTION

This fifth Quarterly Technical Summary Report describes work conducted for the National Aeronautics and Space Administration under Task Order NASr-49(13) during the contractual period September 1 to November 30, 1964. The program is monitored by the Ames Research Center of NASA.

The objective of this study of crosslinked poly(methyl methacrylate) (PMMA) polymers is to obtain information on the behavior of crosslinked polymers in space environments. Of particular interest are the degradative changes in structure which take place *in vacuo* at elevated temperatures, the kinetics associated with the degradation process, and the influence of these changes on the mechanical properties of the polymer.

The new samples of test material were received November 9, and the extension of the Contract became effective on November 16, 1964. Consequently the rate of effort was low during the early months of the reporting period.

II TENSILE STRESS-STRAIN CHARACTERISTICS OF CROSSLINKED PMMA

New samples procured by the Ames Research Center from Polycast Corporation, Stamford, Connecticut were received. These samples consisted of uncrosslinked PMMA and of PMMA crosslinked with varying amounts of either ethylene glycol dimethacrylate (EDMA) or hexamethylene glycol dimethacrylate (HDMA). Table I shows the different amounts (% w/w) of crosslinker used in each sample, and the theoretical number of moles of effective chains per gram of polymer, ν_e, calculated from the relation $\nu_e = 2\ x/100\ M_A$ where x is the weight percent of crosslinker (EDMA: 198, HDMA: 254).

Table I

CROSSLINKED PMMA SAMPLES

Sample No.	Crosslinker Type	Crosslinker Amount (% w/w)	$\nu_e \times 10^4$ (moles/gram)
1	None	--	--
2	EDMA	0.025	0.0253
3	EDMA	1.0	1.011
4	EDMA	6.0	6.06
5	EDMA	16.0	16.17
10	HDMA	0.025	0.0197
11	HDMA	1.0	0.787
12	HDMA	6.0	4.72

Experiments are in progress to determine the equilibrium swelling ratio and the sol fraction of the crosslinked samples in 1,2-dichloroethane and in chloroform.

Rings of 1.580 inches outer diameter and about 1.365 inches inner diameter were cut on a lathe, and Instron tests were carried out on all samples at 145°C at crosshead speeds of 20, 10, 5, 2, 1, 0.5, 0.2, and 0.1 inches/minute. Data are currently being analyzed.

III STRESS RELAXATION

New calibrated thermocouples were installed in the vacuum stress relaxometer. All three load cells are now excited from separate ENDEVCO power supply units. The interconnection of the electronic components of the data acquisition system is displayed in the block diagram, Fig. 1. To ensure accurate voltage regulation the positive error sensor leads of the power supplies were introduced into the vacuum chamber and connected to the strain gages as shown in Fig. 1.

The glass bell jar in which the relaxometer is mounted was replaced with a metal jar for greater ruggedness (the glass bell jar chipped too easily). Instead of an oil bath, an eutectic salt mixture consisting of 53% potassium nitrate, 40% sodium nitrite, and 7% sodium nitrate is being used. This mixture has a melting point of 140°C.

A stress relaxometer, which is suitable for obtaining data in the presence of air, is available. (This apparatus was constructed several years ago for work on another project.) Tests employing this relaxometer have been started recently to obtain data on the PMMA specimen in air at elevated temperatures. Some data of this type are needed so that the results obtained in the vacuum relaxometer can be compared with those obtained in air.

Also in progress is the preparation of a revised computer program for reducing data obtained with the Instron tester at various crosshead speeds and temperatures. The program used previously on this and other projects contained certain minor errors which needed correction; also, the program needed modification because of a change in computer equipment at the Institute.

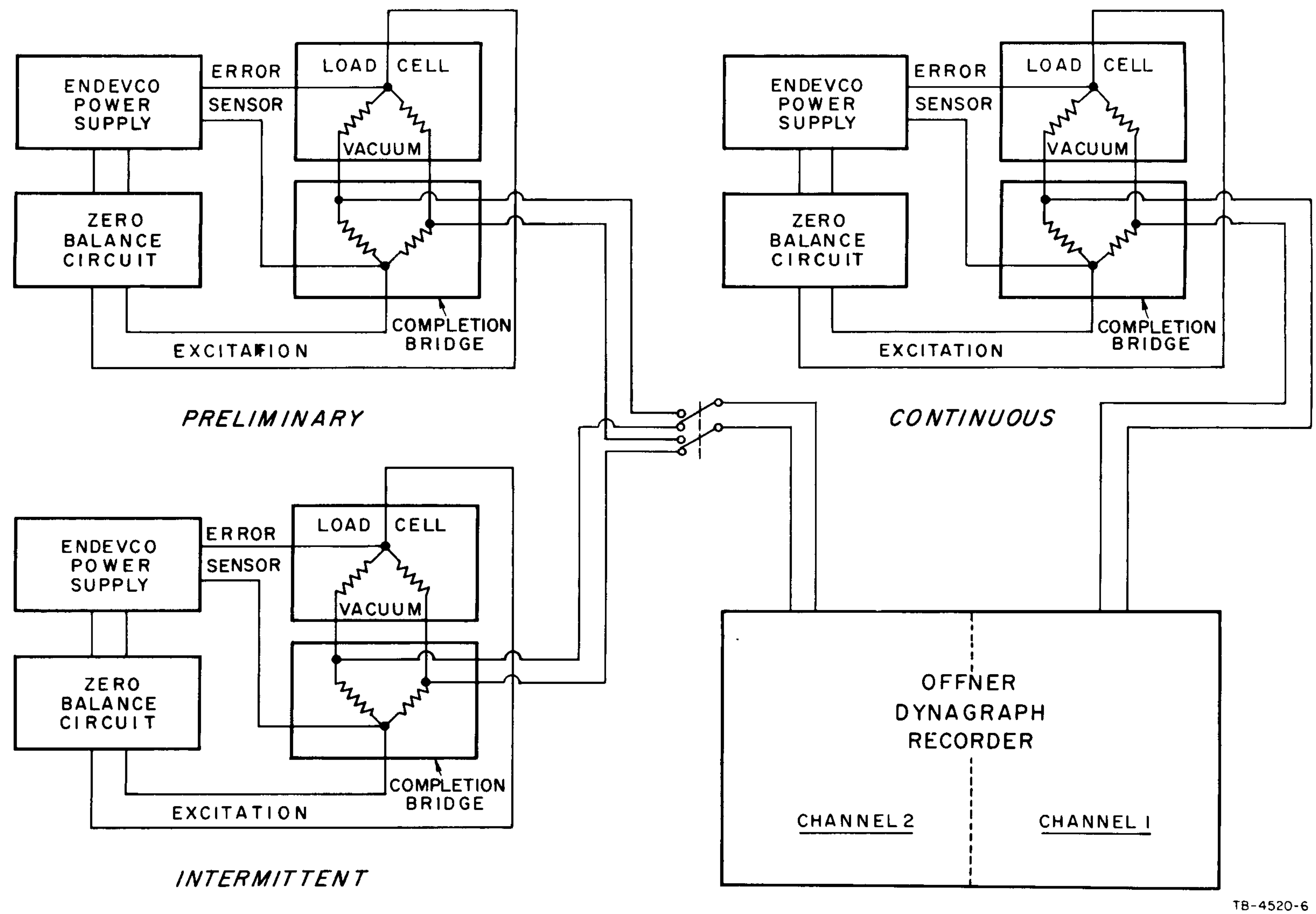

FIG. 1 BLOCK DIAGRAM OF ELECTRONIC COMPONENTS FOR VACUUM RELAXOMETER